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90257

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 2 Physics, 2005

90257 Demonstrate understanding of electricity and electromagnetism

Credits: Five
2.00 pm Tuesday 29 November 2005

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

For all numerical answers, full working must be shown. The answer should be given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences.

Formulae you may find useful are given on page 2.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–10 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

For Assessor's use only	**Achievement Criteria**				
Achievement		**Achievement with Merit**		**Achievement with Excellence**	
Identify or describe aspects of phenomena, concepts or principles.		Give descriptions or explanations in terms of phenomena, concepts, principles and/or relationships.		Give concise explanations that show clear understanding in terms of phenomena, concepts, principles and/or relationships.	
Solve straightforward problems.		Solve problems.		Solve complex problems.	
Overall Level of Performance					

You may find the following formulae useful.

$$E = \frac{V}{d} \qquad F = Eq \qquad \Delta E_p = Eqd$$

$$I = \frac{q}{t} \qquad V = \frac{\Delta E}{q} \qquad V = IR$$

$$P = IV \qquad P = \frac{\Delta E}{t}$$

$$R_T = R_1 + R_2 + \ldots \qquad \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$$

$$F = BIL(\sin\theta) \qquad F = Bqv \qquad V = BvL$$

You are advised to spend 50 minutes answering the questions in this booklet.

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QUESTION ONE: SPRAY PAINTING

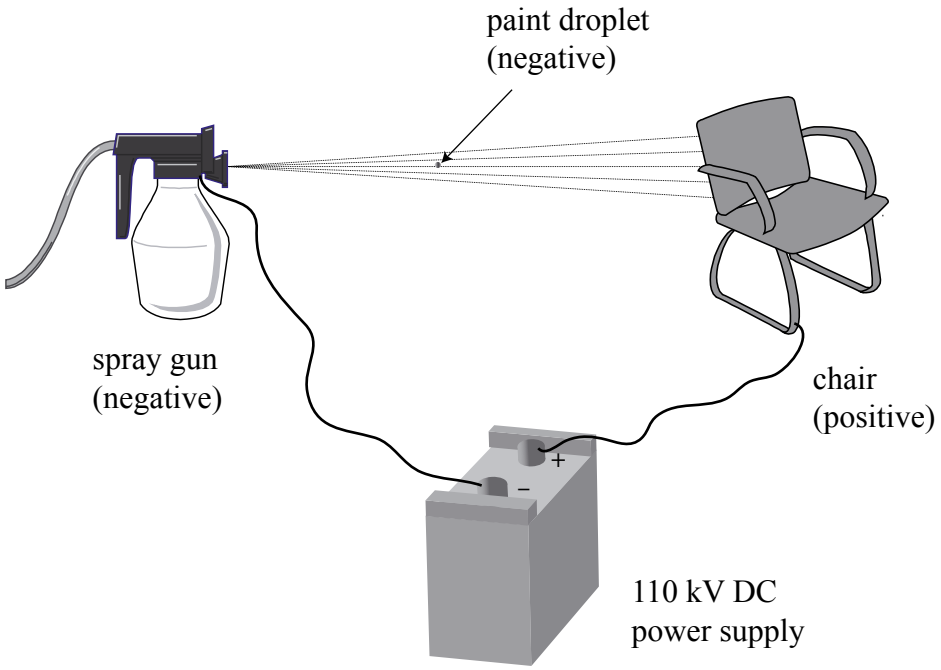
Spray painting involves firing fine droplets of liquid paint at the object to be sprayed. One problem is that many of the droplets miss the object. A solution to this problem is to use electrostatics.

The electrostatic spray painter in the diagram below shows how a metal chair can be painted. The negative terminal of the power supply is connected to the spray gun so the paint droplets become charged.

The positive terminal of the power supply is connected to the chair. This creates an electric field between the spray gun and the chair, and the charged paint droplets are repelled from the gun and attracted to the chair.

(You should assume the electric field is uniform.)

The charge on one electron is: -1.60×10^{-19} C.



(a) Draw an **arrow** on the diagram above to show the direction of the electric field between the spray gun and the chair.

(b) One particular paint droplet has 3.0×10^{6} electrons added to it. **Show** that it has a total charge of -4.8×10^{-13} C.

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(c) The spray gun and chair are 0.65 m apart.

The voltage between the spray gun and the chair is 110 kV.

Calculate the **size** of the **force** acting on the paint droplet described in Question 1(b).

(d) Explain clearly what will happen to the force acting on the paint droplets if the spray gun is moved **closer** to the chair.

(e) Calculate the **change** in electrical potential energy of this paint droplet as it travels from the spray gun to the chair.

(f) State what is meant by the term **electric current**.

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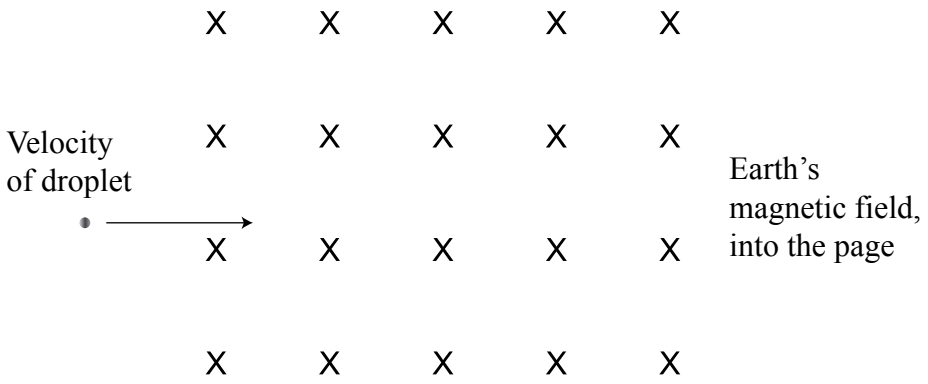
(g) The spray gun fires out 6.5×10^5 paint droplets every minute. The average charge on each paint droplet is -8.0×10^{-13} C. Calculate the size of the electric current from the spray gun.

At one time in its journey to the chair, one paint droplet with a charge of -4.8×10^{-13} C is moving at 12.1 ms^{-1} through the earth's magnetic field as shown in the diagram below. The earth's magnetic field is perpendicular to the paint droplet's velocity and has a strength of 0.071 mT.



(h) Calculate the size of the magnetic force on this paint droplet.
Write your answer to the correct number of significant figures.

(i) The electric field is switched off while the paint droplet is moving. On the **diagram above**, carefully draw the path of the paint droplet as it moves through the magnetic field.
Assume that the magnetic force is the only force acting.

QUESTION TWO: MIKE'S MOTORBIKE

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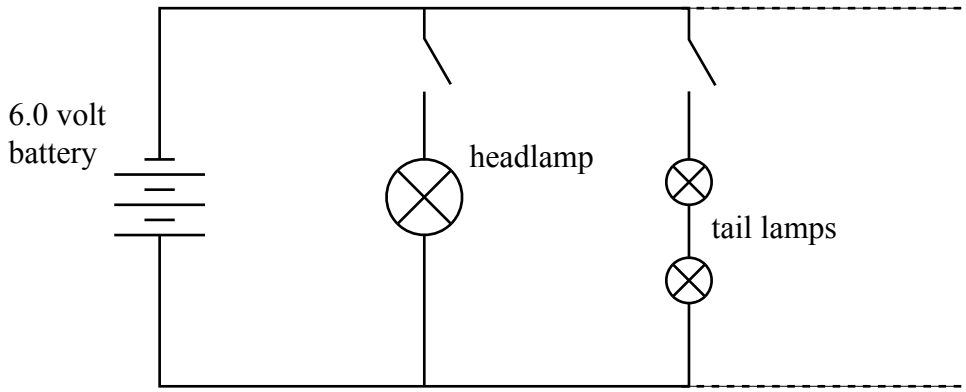
Mike is restoring an old motorbike. The wiring is damaged and he decides to replace it. His sister Moana designs a lighting circuit and draws a wiring diagram. Part of it is shown below. Mike then connects the lighting circuit on the motorbike.

All the lamps are designed to operate at 6.0 V.



(a) The headlamp has a resistance of 1.2 Ω when it is switched on. **Show** that the electric current through the headlamp is 5.0 A.

(b) Calculate the power output of the headlamp when it is operating normally. Give the correct unit with your answer.

_____ _____ (unit)

(c) Explain clearly what will happen to the current in the headlamp in the short time after its switch is first closed.

(d) The battery is producing 6.0 A when both switches are closed. Calculate the **resistance** of each tail lamp, assuming that they are identical.

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QUESTION THREE: MIKE'S MOTORBIKE GENERATOR

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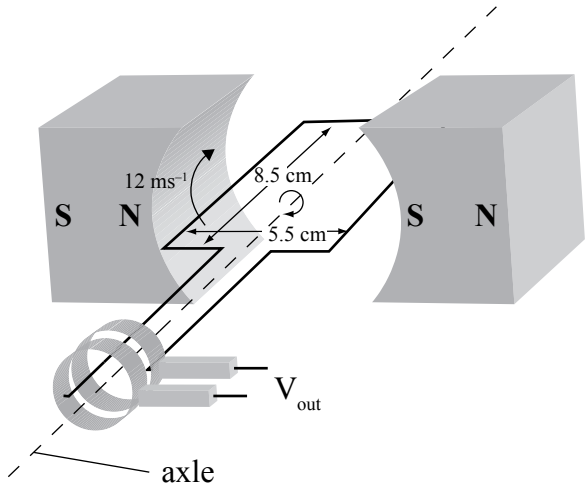
Mike's motorbike has a battery that provides electric current for various components. It also has a generator to provide electric current to charge the battery. The generator is turned by the motorbike's engine.

The generator is essentially a coil of wire that spins between a pair of magnets as shown in the diagram.



The coil is 8.5 cm long and 5.5 cm wide.
The magnetic field strength is 0.070 T.
The speed of the coil is 12 ms^{-1}.
The coil has 45 turns of wire.

(a) Calculate the output voltage of the coil when it is in the position shown.

(b) Determine the size of the voltage a quarter of a cycle later. Explain your answer.

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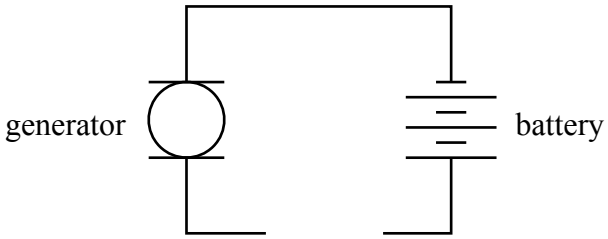
(c) Moana told Mike to put a diode in the circuit so the generator could charge the battery. Draw the correct **symbol** for a diode in the space in the circuit.



(d) Explain clearly why a diode is required in the circuit to charge the battery.

(e) On the axes below, draw a graph of the output voltage of the generator for one cycle, starting at the position shown in the diagram on page 8.

Extra paper for continuation of answers if required.
Clearly number the question.

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Question number	